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IS 10249-1 (1982): Voltage Dependent Resistors (Varistors)
- Part I : General Requirements and Methods of Tests [LITD
5: Semiconductor and Other Electronic Components and
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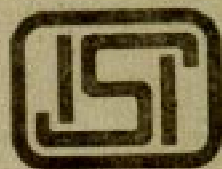
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Indian Standard
SPECIFICATION FOR
VOLTAGE DEPENDENT RESISTORS
(VARISTORS)
PART I GENERAL REQUIREMENTS AND
METHODS OF TESTS

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Indian Standard
**SPECIFICATION FOR
VOLTAGE DEPENDENT RESISTORS
(VARISTORS)**

**PART I GENERAL REQUIREMENTS AND
METHODS OF TESTS**

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Indian Standard
**SPECIFICATION FOR
VOLTAGE DEPENDENT RESISTORS
(VARISTORS)**

**PART I GENERAL REQUIREMENTS AND
METHODS OF TESTS**

0. FOREWORD

0.1 This Indian Standard (Part I) was adopted by the Indian Standards Institution on 23 June 1982, after the draft finalized by the Resistors Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 This standard deals with the general requirements for varistors used in electronics and telecommunication equipments. The dimensional and specific requirements for various types of varistors are covered in subsequent parts of this standard.

0.2.1 If any deviation exist between the standard and relevant detail specification, the provisions of latter shall prevail.

0.3 In the preparation of this standard assistance has been derived from JSS 50650 (1977) General requirements for varistors, issued by Directorate of Standardization, Ministry of Defence, India.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS:2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard (Part I) covers the general requirements and methods of tests for judging electrical, mechanical and climatic properties of varistors intended for use in electronic and telecommunication equipments.

*Rules for rounding off numerical values (*revised*).

2. TERMINOLOGY

2.0 For the purpose of this standard the terms and definitions given in IS:1885(Part XLVI)-1977* together with the following shall apply.

2.1 Varistor — Component whose conductance at a temperature, increases rapidly with voltage. This property is expressed by the following formula:

$$I = KV^\alpha$$

where

I = current through the varistor,

V = voltage applied,

α = exponent of voltage, and

K = constant.

2.2 Nominal Dissipation — Power that a varistor may dissipate while in continuous operation at 25°C without undergoing appreciable permanent changes in electrical and mechanical characteristics.

2.3 Nominal Voltage — The value of voltage that may be continuously applied across the terminals of the varistor at standard atmospheric conditions, the ambient temperature being 25°C.

3. CLIMATIC CATEGORIES

3.1 The climatic category shall be as specified in the relevant specification.

4. MATERIAL, CONSTRUCTION AND WORKMANSHIP

4.1 Material — Varistors shall be constructed from suitable materials which shall be free from flaws. The materials used shall not be susceptible to any mutual chemical reaction over the entire range of climatic conditions in which varistor is designed to operate.

4.2 Construction and Workmanship — Varistors shall be manufactured and processed in accordance with good design and sound Engineering practice.

5. DESIGNATION OF VARISTORS

5.1 Various types of varistors shall be designated by abbreviations, for their identifications, as follows:

- a) The first letter 'V' shall represent the type of component, that is varistor;

*Electrotechnical vocabulary: Part XLVI Resistors.

- b) The second letter shall indicate the type of varistor, disc type, rod type, etc;
- c) The third letter shall indicate whether the varistor is with or without terminations;
- d) The number immediately following the letters together with the preceding letters shall constitute a pattern, and
- e) The last number following the hyphen shall indicate the nominal dissipation.

Example:

For varistor, disc type, with terminations and with nominal dissipation of 1 W, the abbreviation is VDF 1-1.

6. MARKING

6.1 Each varistor shall be clearly and indelibly marked with the following information:

- a) Nominal voltage;
- b) Maximum current at nominal voltage;
- c) Style reference;
- d) Manufacturer's code and date; and
- e) Any additional marking specified in the relevant detail specification.

6.1.1 When coded marking is used, it shall be in accordance with IS:8186-1976*. Varistors may also be colour coded when agreed to between the manufacturer and the user.

6.2 The varistors shall be clearly marked with (a) and (b) given in 6.1 and with as many other items as is practical.

6.3 The package containing the varistor(s) shall be clearly marked with all the information listed in 6.1.

6.4 The varistor(s) may also be marked with the ISI Certification Mark.

NOTE—The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

*Marking codes for values and tolerances of resistors and capacitors.

7. GENERAL CONDITIONS FOR TESTS

7.1 Selection of Samples — The samples for test shall be so selected as to be representative of the voltage range, wattage rating, temperature classification and category of the varistors under consideration.

7.2 Following conditions shall be kept in view while making measurements:

- a) Only dc voltage shall be used for measurement;
- b) The measuring time shall be kept as short as possible, since self-heating effects may influence the measurements due to negative temperature coefficient (N.T.C.) of varistors; and
- c) Since the varistors have no polar effect the voltage may be applied in any direction.

7.3 Atmospheric Conditions for Tests — Unless otherwise specified, the tests shall be carried out under standard atmospheric conditions for testing as specified in IS:9000 (Part I)-1977*.

7.4 Preconditioning — Before measurements are made the varistors shall be stored at the measurement temperature and relative humidity for sufficient time to allow the varistors to reach these conditions. The recovery period allowed for, after climatic conditioning is normally adequate for this purpose.

7.5 Corrections to be Applied — When measurements are made at a temperature other than the reference temperature, the results shall, wherever necessary, be corrected to the reference temperature. The ambient temperature during the test shall be stated in the report.

7.6 Drying — When drying is called for in this standard, the varistors shall be conditioned before measurement is made using Procedure I or Procedure II as prescribed in the relevant specification.

- a) Procedure I — For 24 ± 4 hours in an oven at a temperature of $55 \pm 2^{\circ}\text{C}$ and at a relative humidity not exceeding 20 percent.
- b) Procedure II — For 96 ± 4 hours in an oven at $100 \pm 5^{\circ}\text{C}$.

7.6.1 The variable resistor shall then be allowed to cool in a desiccator using a suitable desiccant, such as activated alumina or silica gel, and shall be kept therein from the time of removal from the oven to the beginning of the specified test.

*Basic environmental testing procedures for electronic and electrical items: Part I General.

8. TESTS

8.1 Electrical Tests

8.1.1 Current at Nominal Voltage — The nominal voltage as specified shall be applied across the terminals of the varistor and the corresponding value of the current shall be measured. The voltage shall be applied for a period of 2 seconds. The value shall not exceed the limits specified in the relevant detail specification.

8.1.2 Voltage Proof (*Applicable to Insulated Type Only*) — Under consideration.

8.1.3 Insulation Resistance (*Applicable to Insulated Type Only*) — Under consideration.

8.1.4 Overload — The specimens shall be placed in the test chamber maintained at a temperature of the maximum temperature severity $\pm 2^{\circ}\text{C}$ throughout the test. During the test the specimens shall be subjected to a voltage equal to 1.2 times the nominal voltage. Duration of the test shall be 24 ± 1 hours. On completion of the tests, the following measurements shall be made after recovery under standard atmospheric conditions for 2 to 4 hours.

8.1.4.1 The specimens shall be visually examined. There shall be no mechanical deterioration. Markings shall remain legible and indelible.

8.1.4.2 Current at nominal voltage shall be measured in accordance with 8.1.1 and the change from the initial value shall not exceed the limit specified.

8.1.5 Temperature Coefficient — The specimens shall be dried using either procedure I or II of 7.6 as specified in the relevant specification. Then, the test shall be performed as follows.

8.1.5.1 Procedure I — The current at nominal voltage shall be measured in accordance with 8.1.1 at the following temperatures after the specimens have obtained thermal stability, in the order listed below:

- a) $20^{\circ}\text{C} \pm 1^{\circ}\text{C}$;
- b) Minimum temperature of temperature severity $\pm 0^{\circ}\text{C}$;
- c) $20^{\circ}\text{C} \pm 1^{\circ}\text{C}$; and
- d) Maximum temperature of temperature severity $\pm 2^{\circ}\text{C}$.

NOTE 1 — The measurement of temperature shall be accurate to $\pm 1^{\circ}\text{C}$.

NOTE 2 — The temperature at (a) shall be the reference temperature for (b). The temperature at (c) shall be reference temperature for (d).

The temperature coefficient shall be calculated from the following formula:

$$\text{Temperature coefficient (percent/}^{\circ}\text{C) } = \frac{I_2 - I_1}{I_1 (T_2 - T_1)} \times 100$$

where

- I_1 = current at nominal voltage and at reference temperature;
- I_2 = current at the nominal voltage and at test temperature;
- T_1 = reference temperature in $^{\circ}\text{C}$; and
- T_2 = Test temperature in $^{\circ}\text{C}$.

8.1.5.2 Procedure II— The voltage at the specified current shall be measured at the following temperatures after the specimens have obtained thermal stability, in the order listed below:

- a) $20^{\circ}\text{C} \pm 1^{\circ}\text{C}$;
- b) Minimum temperature of temperature severity $\pm 0^{\circ}\text{C}$;
- c) $20^{\circ}\text{C} \pm 1^{\circ}\text{C}$; and
- d) Maximum temperature of temperature severity $\pm 0^{\circ}\text{C}$.

NOTE 1 — The measurement of temperature shall be accurate to $\pm 1^{\circ}\text{C}$.

NOTE 2 — The temperature at (a) shall be the reference temperature for (b). The temperature at (c) shall be the reference temperature for (d).

$$\text{Temperature coefficient (percent/}^{\circ}\text{C) } = \frac{V_2 - V_1}{V (T_2 - T_1)} \times 100$$

where

- V_1 = voltage at the specified current and at reference temperature;
- V_2 = voltage at the specified current and at test temperature;
- T_1 = reference temperature in $^{\circ}\text{C}$; and
- T_2 = test temperature in $^{\circ}\text{C}$.

NOTE — The measurement of temperature shall be accurate to $\pm 1^{\circ}\text{C}$.

8.2 Mechanical Tests

8.2.1 General Examination

8.2.1.1 Visual examination— The condition, workmanship and finish of the specimen shall be satisfactory when examined visually. The markings shall remain legible and indelible.

8.2.1.2 Outline dimensions — The dimensions shall be checked for compliance to the outline drawings given in relevant specification.

8.2.2 Robustness of Terminations — The test shall be carried out in accordance with IS:9000 (Part XIX)-1978*. On completion, the following measurement shall be made.

8.2.2.1 The specimens shall be visually examined. There shall be no breaking or loosening of terminations, or any other evidence of mechanical deterioration.

8.2.3 Bump — This test shall be carried out in accordance with IS:9000 (Part VII/Sec 2)-1979*. On completion, the following measurement shall be made.

8.2.3.1 The specimens shall be visually examined. There shall be no fracture, loosening of parts or any other mechanical deterioration.

8.2.4 Vibration — The test shall be carried out in accordance with IS:9000 (Part VIII)-1981*. On completion, the following measurement shall be made.

8.2.4.1 The specimen shall be visually examined. There shall be no fracture or loosening of parts or other mechanical deterioration.

8.2.5 Shock — The test shall be carried out in accordance with IS:9000 (Part VII/Sec 1)-1979*. On completion, the following measurement shall be made.

8.2.5.1 The specimen shall be visually examined. There shall be no fracture, loosening of parts or any other mechanical deterioration.

8.2.6 Acceleration (Steady State) — The test shall be carried out in accordance with IS:9000 (Part IX)*. On completion, the following measurement shall be made.

8.2.6.1 The specimen shall be visually examined. There shall be no fracture, loosening of parts or any other mechanical deterioration.

8.2.7 Solderability — The test shall be carried out in accordance with IS:9000(Part XVIII/Sec 1)-1981*. Each termination shall be tested.

*Basic environmental testing procedures for electronic and electrical items:

Part XIX Test for robustness of terminations and integral mounting devices.

Part VII Impact test, Sec 2 Bump.

Part VIII Vibration (Sinusoidal) test.

Part VII Impact test, Sec 1 Shock.

Part IX Acceleration (steady state) test (*under preparation*).

Part XVIII Solderability test, Sec 1 Solderability of wire and tag terminations.

8.2.8 Resistance to Soldering Heat (Not Applicable to Varistors Without Terminations) — The test shall be carried out in accordance with IS:9000 (Part XVIII/Sec 3)-1981*. The current at nominal voltage shall be measured in accordance with 8.1.1. On completion the following measurements shall be made.

8.2.8.1 The specimens shall be visually examined. There shall be no mechanical deterioration, markings shall remain legible and indelible.

8.2.8.2 The current at nominal voltage shall be measured in accordance with 8.1.1. The change from the value recorded at 8.2.8 shall not exceed the limit specified.

8.3 Climatic Tests

8.3.1 Climatic Sequence — The sequence of tests shall be in accordance with IS:9000 (Part I)-1977*. The specimens shall be dried as in 7.6, Procedure I. The specimens shall be mounted by their normal means and the current at nominal voltage shall be measured in accordance with 8.1.1. The following tests shall be made subsequent to removal from the conditioning chambers for temperature (dry heat), temperature (dry cold), damp heat (cyclic, one cycle only), low air pressure, damp heat (cyclic, remaining cycles).

8.3.1.1 Visual examination — The specimens shall be visually examined. There shall be no corrosion, fracture, loosening of parts or mechanical deterioration. The marking shall be legible and indelible.

8.3.1.2 Temperature (dry heat) — This test shall be carried out in accordance with IS:9000 (Part III/Sec 5)-1977*.

8.3.1.3 Temperature (dry cold) — This test shall be carried out in accordance with IS:9000 (Part II/Sec 4)-1977* at the minimum temperature of the temperature severity.

8.3.1.4 Damp heat (cyclic, one-cycle) — This test shall be carried out in accordance with IS:9000 (Part V/Sec 2)-1981*.

8.3.1.5 Low air pressure — This test shall be carried out in accordance with IS:9000 (Part XIII)-1981*. During the last five minutes of the test,

*Basic environmental testing procedures for electronic and electrical items:

Part XVIII Solderability test, Sec 3 Solderability of printed boards and metal clad base laminates.

Part I General.

Part III Dry heat test, Sec 5 Dry heat for dissipating items with gradual change of temperature.

Part II Cold test, Sec 4 Cold test for heat dissipating items with gradual change of temperature.

Part V Damp heat (cyclic) test, Sec 2 12+12 h cycle.

Part XIII Low air pressure test.

the specimens shall be loaded for 50 percent of the rated dissipation, subject to their low air pressure voltage limitation. There shall be no breakdown or flashover.

8.3.1.6 Damp heat (cyclic, remaining cycles) — This test shall be carried out in accordance with IS : 9000(Part V/Sec 1)-1981*. The following measurements shall be made at the completion of the test.

- a) *Working test* — Within 15 minutes after removal from the chamber, the specimen shall be subjected to rated dissipation for a period of one minute. There shall be no breakdown or flashover.
- b) *Visual examination* — The specimens shall be visually examined. There shall be no fracture, loosening of parts or any other mechanical deterioration. The marking shall be legible and indelible.
- c) The current at nominal voltage shall be measured in accordance with 8.1.1. This shall not exceed the limit specified.
- d) The insulation resistance shall be measured and shall be as specified in the relevant specifications.

8.3.2 Damp Heat (Steady State) — This test shall be carried out in accordance with IS : 9000(Part IV)-1979*. Half the number of specimens shall be tested without loading during exposure. For the other half of the specimens 80 to 100 percent of the nominal voltage, shall be applied across the terminations. Within 15 minutes after removal from the chamber, the specimens shall be loaded for rated dissipation for one minute. There shall be no breakdown or flashover. The following measurements shall be made after completion of the appropriate recovery period.

8.3.2.1 Visual examination — There shall be no corrosion, fracture, loosening of parts or any other mechanical deterioration.

8.3.2.2 Voltage proof — After this test there shall be no breakdown or flashover.

8.3.2.3 Insulation resistance tests — The Insulation resistance shall be measured and shall be as specified in the relevant specification.

8.3.2.4 Current at nominal voltage — This test shall be carried out in accordance with 8.1.1 and shall not exceed the value specified.

8.3.2.5 Robustness of terminations — This test shall be carried out in accordance with 8.2.2.

*Basic environmental testing procedures for electronic and electrical items:

Part V Damp heat (cycle) test, Sec 1 16+8 h cycle.

Part IV Damp heat (steady state).

8.3.3 Mould Growth — This test shall be carried out in accordance with IS : 9000(Part X)-1979*.

8.3.4 Salt Mist Test — This test shall be carried out in accordance with IS : 9000(Part XI)*. After the test specimens shall be visually examined. There shall be no corrosion or loosening of parts or any other mechanical deterioration. The markings shall be legible and indelible.

8.3.5 Rapid Change of Temperature — This test shall be carried out in accordance with IS : 9000(Part XIV)-1978*. The current at nominal voltage shall be measured in accordance with 8.1.1. After the test, the following measurements shall be made.

8.3.5.1 Visual examination — The specimens shall be visually examined. There shall be no fracture, loosening of parts or any other mechanical deterioration. The marking shall be legible and indelible.

8.3.5.2 Current at nominal voltage — The current at nominal voltage shall be measured in accordance with 8.1.1 and shall not exceed the specified value.

8.4 Miscellaneous Tests

8.4.1 Resistance to Solvents — This shall be carried out in accordance with IS : 9000(Part XX)-1979*. That portion of the specimen where marking is present shall be brushed. The marking shall remain legible and shall not smear or rub off. There shall be no evidence of mechanical deterioration.

8.4.2 Flammability — This shall be conducted in accordance with IS : 9000(Part XXI)*. One specimen of each type shall be tested.

8.4.3 Electrical Endurance — The specimens shall be placed in the test chamber in such a manner that no specimen is within 50 mm of any other specimen. There shall be no undue drought over the specimens. The specimens shall be connected by their terminations to suitable clips on a rack of insulating material. The size of the test chamber and the number of specimens under test shall be such that when all the specimens are fully loaded, it is possible to control the temperature by the heating elements. The temperature controlling elements shall be suitably spaced from the specimens and shall be shielded so as not to be directly influenced by the radiation of the specimens. Only one layer shall be placed in the chamber.

*Basic environmental testing procedures for electronic and electrical items:

Part X Mould growth test.

Part XI Salt mist test (*under preparation*).

Part XIV Change of temperature.

Part XX Resistance to cleaning solvents and permanence of markings.

Part XXI Flammability test (*under preparation*).

Unless otherwise specified, the nominal voltage shall be applied intermittently, one hour on and one hour off, for 1000 ± 24 h. The test shall be carried out at atmospheric conditions. The efficiency shall be measured in the beginning of the test in accordance with 8.4.5.

8.4.3.1 The following measurements shall be carried out during the test at the end of one hour off periods, after allowing recovery period of 4 hours \pm 30 minutes, at the end of 250 ± 24 hours and 500 ± 24 hours:

- a) The specimen shall be visually examined. There shall be no mechanical deterioration and the marking shall be legible.
- b) The current at nominal voltage shall be measured in accordance with 8.1.1. The change from the initial value shall not exceed the limit specified.

8.4.3.2 The following measurements shall be made at the conclusion of the test. Specimens, after removal from the chamber shall be allowed to cool under standard atmospheric conditions for a period of 4 hours \pm 30 minutes:

- a) The specimen shall be visually examined. There shall be no mechanical deterioration and the marking shall be legible.
- b) Insulation resistance shall be measured in accordance with 8.1.3 and shall not exceed the value specified.
- c) The current at nominal voltage shall be measured in accordance with 8.1.1. The change from the initial value shall not exceed the limit specified.
- d) Efficiency shall be measured in accordance with 8.4.5 and shall not exceed the value specified.

8.4.4 Endurance Operational — The test shall be conducted under the atmospheric conditions for one million cycles. Unless otherwise specified, the nominal voltage shall be applied intermittently for 0.5 seconds on and 0.5 seconds off.

8.4.4.1 Efficiency — Efficiency shall be measured in the beginning of the test in accordance with 8.4.5.

8.4.4.2 On completion of the test, the following measurements shall be made after a recovery period of 4 hours \pm 30 minutes under atmospheric conditions of testing:

- a) *Visual examination* — The specimen shall be visually examined. There shall be no mechanical deterioration and the marking shall be legible.

- b) The current at nominal voltage shall be measured in accordance with 8.1.1. The change from the initial value shall not exceed the limit specified.
- c) Efficiency shall be measured in accordance with 8.4.5 and shall not exceed the value specified.

8.4.5 Efficiency — The varistor shall be connected to a constant current source. A current pulse of specified magnitude and of the duration less than or equal to 50 ms shall be applied to the varistor. Care shall be taken to ensure that the average power dissipated during the test shall not exceed the nominal dissipation.

NOTE — The stray capacitance of the constant current source shall not be more than 1000 pF.

A suitable voltmeter or oscilloscope shall be used to measure the peak value of the voltage across the terminals of the varistor.

8.4.5.1 The maximum voltage measured across the terminals of the varistor during the test shall not exceed the value specified.